Freshwater lenses under the Murray

National Centre for Groundwater Research and Training

This resource introduces the research that NCGRT scientists are doing into freshwater lenses – or pockets of fresh groundwater surrounded by saline water – along the River Murray. This resource is intended for a general audience.

A SALTY LANDSCAPE

Freshwater lenses are more commonly researched when they occur on small coral or limestone islands. There, a 'lens' means a convex layer of fresh groundwater, formed when rain seeps down through the soil and gathers on top of seawater that is found in the sediments of the island below sea level. However, freshwater lenses also occur far from sea, in the Murray–Darling Basin.

In many places near the River Murray, the groundwater is very saline. This is in large part due to our native vegetation, which is very efficient at using the little rain that falls, leaving behind the salts that were dissolved in the water. Over time, this remaining saline water permeates the ground, and so the groundwater in some aquifers in the Murray system is very salty.

Overall, there's very little fresh groundwater in many parts of the Murray–Darling Basin. The fresh groundwater that does exist is often found below and alongside the rivers, surrounded by saline water – these fresh pockets are known as freshwater lenses.

LEAKY RIVERS

The reason that fresh water exists below and around rivers is that rivers are often quite leaky. For example, in the region studied, the River Murray sits above the water table, and when there are strong flows down the river, the water is pushed out through the bottom and sides of the river bed and into the surrounding aquifers, creating freshwater lenses in a 'sea' of saline groundwater. These lenses are quite shallow and can be accessed by bores near to the river.

KiwiMike2009, Flickr

The major freshwater lenses in the Murray–Darling Basin have been known about for some time, but have never been extensively studied. There may be smaller unknown groundwater lenses on other river reaches in the Basin that are not extensively developed or monitored.

RESEARCH IN THE MALLEE

Researchers from the National Centre for Groundwater Research and Training (NCGRT), building on previous research, have been studying a major freshwater lens along the River Murray in the Victorian Mallee. This lens runs from Nyah near Swan Hill, to Red Cliffs near Mildura.

Utilising a set of hundreds of Victorian government bores, which run in rows perpendicular to the Murray from Nyah to the South Australian border, researchers have been able to gather enough data to learn more about these phenomena.

A DYNAMIC SYSTEM

The main exciting finding of the research was that the lenses are active today, unlike much groundwater, which can be 'fossil water', hundreds of thousands of years old.

Using radioactive dating techniques, the researchers traced naturally-occurring carbon-14 and tritium, and found that the groundwater close to the river is decades old, while water a little further away from the river is a few thousand years old. This means that the lenses are actively forming today.

Furthermore, the researchers found that the lenses are dynamic, and change size and shape according to the amount of rainfall and water flowing down the river. Looking back at records through the 1980s for this area – a period of high rainfall – the researchers could see that the lens expanded. Using bores on the edge of the floodplain far from the river, researchers could get a 'birds eye view' of the changing groundwater. Over time they could see that the water in these bores became fresher and fresher

Want to know more?

NCGRT research into freshwater lenses is led by Professor Ian Cartwright. For more detailed information, the following papers may prove useful:

Cartwright I, Weaver TR, Simmons CT et al., 2010, 'Physical hydrogeology and environmental isotopes to constrain the age, origins and stability of a low-salinity groundwater lens formed by periodic river recharge: Murray Basin, Australia, Journal of Hydrology, vol. 380, pp. 203–221.

Cartwright I, Hofmann H, Sirianos MA et al., 2011, 'Geochemical and 222Rn constraints on baseflow to the Murray River, Australia, and timescales for the decay of low-salinity groundwater lenses', Journal of Hydrology, vol. 405, pp. 333–343.

during a long wet period, while as the drought began to set in in the 1990s, the bores became more and more saline.

Previously, scientists had thought that the dimensions of freshwater lenses were limited by geology; now we know that each lens is more like a balloon that expands and contracts than a glass that fills up and empties.

A BUFFER BETWEEN RIVER AND AQUIFER

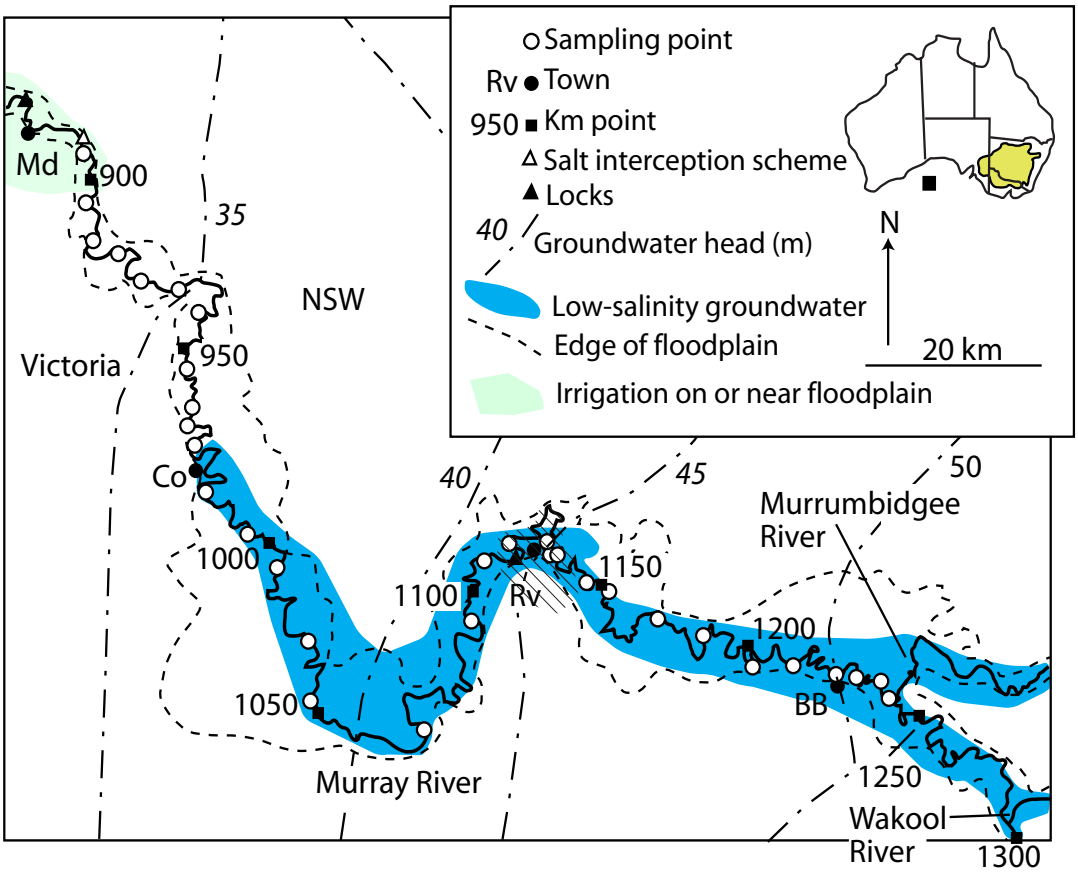
Knowing a little more about the freshwater lenses along the Murray helps us to manage groundwater wisely.

Although there has been some suggestion that these lenses could be used as a freshwater supply in drought times, this is not really practical. In the first place, there are relatively small quantities of fresh water, so they probably wouldn't help farmers to sustain established crops like citrus and almonds. But more importantly, learning that these systems are dynamic lets us know that, while in wet times the river feeds the nearby aquifers, in dry times, the lenses actually drain back into the river, and act as a buffer between the river and the more saline groundwater. If we were to deplete the fresh water from the lenses, during drought the river would be fed by the very saline regional groundwater, and this could have a detrimental effect on the river and its ecosystems.

Another benefit of healthy freshwater lenses is that, being quite shallow, they probably feed the iconic River Red Gum forests along the Murray, along with other riparian vegetation. Knowing how freshwater lenses behave is important for managing the local water balance and native ecosystems.

OPPORTUNITIES FOR FUTURE RESEARCH

Now that we know more about how freshwater lenses work, the next challenge is to accurately model and predict their behaviour. In particular, these lenses incorporate a transition zone, from fresh water to saline water, and we'd like to know how this transition zone forms, how the fresh water and saline waters move in relation to each other and how they interact. This is quite a modelling challenge, and something that NCGRT researchers are working on into the future.



This map of the River Murray shows the freshwater lens (marked in blue) discussed, including the Victorian side of the lens studied by the NCGRT team.

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